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The Effects of an Eight Week Developmental Physical Education Program on Physical Fitness Index and Certain Cardiovascular Factors of Freshman Male Students

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THE EFFECTS OF AN EIGHT WEEK DEVELOPMENTAL PHYSICAL EDUCATION PROGRAM ON PHYSICAL FITNESS INDEX AND CERTAIN CARDIOVASCULAR FACTORS OF FRESHMAN MALE STUDENTS

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This thesis is approved as a creditable, independent investigation by a candidate for the degree, Master of Science, and acceptable as meeting the thesis requirements for this degree; but without implying that the conclusions reached by the candidate are necessarily the conclusions of the major department.

Thesis Adviser

Head of the Major Department

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CHAPTER I

THE PROBLEM

Introduction

On June 18-19, 1956, the first peacetime conference on fitness of American youth was held under White House auspices because President Eisenhower was given reason to believe that the youth of our country were generally falling into a state of unfitness and that more should be done to help them become physically fit and better qualified to face the requirements of modern life.

The President's Conference, in addition to the findings of the Kraus-Weber Test[1], has served to focus national attention on the fitness status of American youth. It is rapidly being realized that physical fitness means much more than freedom from sickness, or being able to engage in physical activities, games, and contests. Physical fitness is a definite and positive quality which every individual possesses to some degree within limits of his inherited capabilities. It is evident that many American children are not up to this inherited capacity.

Clarke[2] defines physical fitness as the development and mainten-

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[1]Hans Kraus, and Ruth P. Hirschland, "Muscular Fitness and Health", Journal of Health, Physical Education, and Recreation, XXIV, December, 1953, pp. 17-19.

[2]H. Harrison Clarke, The Application of Measurement to Health and Physical Education, (2nd Edition; New York: Prentice Hall Inc., 1953), pp. 12-13.

ance of a sound physique and of soundly functioning organs, to the end that the individual realizes in an optimum measure his capacity for physical activity as well as for mental accomplishments, unhampered by physical drains or by a body lacking in physical strength and vitality. An individual is considered physically fit when his capacity for performance and endurance in physical activity is great, when it is equal to his own potentiality. McCloy[3] feels that

> "Physical fitness is the composition of:
> 1. inheritance of high grade organs, both structurally and functionally
> 2. the lack of pathological functioning of the organs; a healthy individual
> 3. the absence of bad hygienic habits
> 4. physical conditioning to a degree which depends upon the individual's work
> 5. endurance to include a concomitant of more strength, development of a greater capillary bed in the muscle, circulo-respiratory endurance, and autonomic nervous system adaptability to fatigue
> 6. having an adequate degree of bodily flexibility."

Cureton[4] states that

> "Physical fitness is one phase of total fitness and is composed of three basic principles:
> 1. appraisal of physique
> 2. appraisal of organic efficiency
> 3. appraisal of motor fitness."

He goes on to describe the meaning of these three components of physical fitness.

> "Physique represents the obvious first impression due to appearance. In a fit person we usually look for the following characteristics:

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[3] C. H. McCloy, "What is Physical Fitness?", Journal of Health, Physical Education, and Recreation, XXVII, September, 1956, pp. 14-15, 38.

[4] Thomas K. Cureton, Physical Fitness Appraisal and Guidance, (St. Louis: The C. V. Mosby Company, 1947), pp. 18-21.

1. healthy and robust appearance
2. muscular development strongly in evidence
3. good posture with appearance of ease, alertness, and poise
4. good proportions of bone, muscle, and fat quotas
5. normal bones, joints, and muscles
6. good size for age and sex."

"Organic condition implies the relative state of health and efficiency of the organs of the body. Specific aspects are
1. normal sense organs-sight, hearing, smell, taste, feeling
2. fit heart and circulatory system with marked resistance to cardiovascular fatigue
3. fit glands of internal secretion and blood
4. fit digestive system and good teeth
5. fit muscular system in development and tone
6. fit nervous system for rhythmic alternation of abundant energy and relaxation
7. normal sexual vigor and virility
8. normal excretory and evacuation system."

"Specific aspects of motor fitness are
1. at least average capacity in a wide variety of fundamental motor abilities-balance, flexibility, agility, strength, power, and endurance activities
2. sufficient swimming ability to save a life
3. at least average skill in basic skills of running, jumping, climbing, crawling, and throwing
4. some specialized skills for adult social recreation such as golf, tennis, swimming, archery, ping pong, bowling, shooting, riding, cycling, skating, skiing, etc.".

According to the various definitions, physical fitness is a qualitative element composed of many factors; so in order to properly evaluate physical fitness, it would be necessary to measure all of the various factors. It is generally conceded that a test is needed that will be sensitive to the effects upon the organism of lack of exercise, of faculty health habits, and of organic drains.

The Roger's Physical Fitness Test was intended to be such a measure. This test is based upon the assumption that to rate well, one must have efficiently functioning organs and well-developed muscles; however, the relative proportion of skill, effort, cardiovascular condition, body build factors, and absolute strength entering into the test is relatively unknown.

The ideal situation in testing physical fitness would be to be able to administer a test and from the results judge the degree of physical fitness a person possesses in terms of physical strength, organic efficiency, and motor fitness. At the present time, the Roger's Physical Fitness Test is the best available instrument to measure physical fitness.

Statement of Problem

The purpose of this study was to determine the effects of eight weeks of developmental physical education upon certain cardiovascular conditions of twenty men students with physical fitness indices of eighty-five and below and twenty men students with a physical fitness index of eighty-six and above.

Specifically the purposes of the study are as follows: (1) to determine the effects of a developmental program on the pulse rate, (2) to determine the effects of a developmental program on the systolic and diastolic blood pressure, (3) to determine the effects of a developmental program on the fatigue ratio, and (4) to determine the changes in physical fitness index for the two groups after a developmental program.

CHAPTER II

RELATED LITERATURE

Physical Fitness Index

The idea of using strength tests as a measure of physical fitness is not new. As early as 1702 there were reports of studies on the physical strength of man. The idea of combining strength tests into a formal battery for the purpose of measuring a person's physical ability dates back to the latter part of the 19th century. Dr. Dudley A. Sargeant, in 1880, proposed such a test battery and began the systematic measuring of Harvard students for the purpose of determining physical standards for the American college student. Out of this work developed the Intercollegiate Strength Test, consisting of a battery of ten test items for the measuring of the strength of the back, legs, right and left grip, pull-ups, and push-ups. Vital capacity was also measured.[5]

It was not until 1925, however, when Dr. Frederick Rand Rogers standardized testing procedures and developed norm tables for their interpretation, in which manner he established the relationship between physical condition, athletic performance, and muscular strength.[6]

In selecting the individual elements composing the physical fitness index, Rogers tried to include only tests that would measure most of the

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[5]H. Harrison Clarke, <u>The Application of Measurement to Health and Physical Education</u>, (2nd Edition; New York: Prentice Hall Inc., 1953), p. 137.

[6]H. Harrison Clarke, <u>The Application of Measurement to Health and Physical Education</u>, (2nd Edition; New York: Prentice Hall Inc., 1953), p. 137.

large muscles of the body. Roger's test consists of measurements of weight and height, right and left hand grip, leg and back life, push-ups, lung capacity, and pull-ups.

Upon measuring the strength items plus lung capacity, a gross score known as the strength index is obtained. The strength index is proposed as a measure of general athletic ability and should be conceived neither as a measure of skill in any particular sport nor as a measure of physical fitness.

The physical fitness index is a score derived from comparing an achieved strength index with a norm based upon the individual's sex, weight, and age. It is a measure of general physical fitness indicating the immediate capacity of the individual for physical activity. A physical fitness index of 100 is considered average according to Roger's national survey.

In order to better understand the physical fitness index and to evaluate its significance, two important concepts should be made clear. First, in order for a condition to affect the physical fitness index, it must have systemic implications, that is, be total body in its reaction. If, therefore, such conditions as body fatigue, lack of exercise, improper diet, diseased tonsils, abscessed teeth, ulcers, cancer, and the like have total-body reactions, the strength of the muscle is affected and the physical fitness index declines.[7] The second important concept is that a

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[7]H. Harrison Clarke, The Application of Measurement to Health and Physical Education, (2nd Edition; New York: Prentice Hall Inc., 1953), pp. 156-157.

physical fitness index is a generalized index, as the name implies, not a diagnosis. A low physical fitness index indicates a lack of physical condition, a lowered body vitality, but not what the cause might be. A person should not conclude that he or she can, from the physical fitness index, diagnose causes of deficiencies. The fact is quite otherwise, a low or high index is merely a danger sign which shows that the individual could use the help of the physical educator or maybe the physician.[8]

In the selection of physical fitness index cases for study and treatment there are three groups of individuals which a person should consider: (1) individuals with physical fitness indices in the lower range, (2) individuals whose physical fitness indices decline on repeated test, regardless of their physical fitness index level, and (3) individuals with extremely high physical fitness indices.

Cardiovascular Fitness

Physiological tests, especially of cardiovascular nature, have been experimented with in this country since 1884, when Angelo Mosso, an Italian physiologist, invented the ergograph. Mosso's original premise was that the ability of a muscle to perform was dependent upon the efficiency of the circulatory system, the efficiency with which fuel is supplied to the muscle, and the efficiency with which waste materials are carried away. Since then, many other experimenters have worked in this field, claiming that tests based upon the cardiovascular function measured

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[8]H. Harrison Clarke, The Application of Measurement to Health and Physical Education. (2nd Edition; New York: Prentice Hall Inc., 1953), pp. 156-157.

qualities variously described by such terms as functional health, physiological efficiency, organic condition, athletic condition, physical fitness, and endurance.

According to McCloy[9] there have been only a few cardiovascular tests devised that have an adequate degree of accuracy in measuring one specific type of physiological efficiency. This is partly because the cardiovascular mechanisms are not yet thoroughly understood, and because some of the cardiovascular variables, such as diastolic pressure and venous pressure, have not been generally utilized.

McCloy further states that there are some physiological principles involved in cardiovascular tests and that some of the variables that can be readily measured in cardiovascular testing are pulse rate, systolic and diastolic blood pressure, and venous pressure. Each of these variables are probably modified by a number of physiological mechanisms, and some of these are as yet not thoroughly understood.

In general the following factors are considered by McCloy as accompanying good and poor condition: Good condition: slow pulse, little rise in rate of pulse upon arising from reclining position, fairly high diastolic pressure, normal systolic pressure, rise of systolic pressure upon arising from reclining position, relatively high venous pressure, relatively small increase in pulse rate after exercise, rapid recovery of pulse rate after cessation of exercise.

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[9]C. H. McCloy, Test and Measurements in Health and Physical Education, (New York: Appleton-Century Croft Company, 1954), pp. 238-239.

Poor condition is indicated by fast pulse rate, relatively great change in rate of pulse upon arising from reclining position, relatively low systolic pressure, drop in systolic pressure upon arising from reclining position, fairly low diastolic pressure, fairly low pulse pressure, low venous pressure, great increase in pulse rate after exercise, and slow recovery of pulse rate after ceasing exercise.

Pulse Rate

Cureton[10] states that the pulse rate test is the easiest and simplest way to check circulatory-respiratory fitness. He goes on to say that pulse rate does not represent a complete test of circulatory-respiratory fitness, but it is the easiest to measure and is the most reliable of the physiological variables which reflect the internal bodily efficiency in response to exercise. Within moderate limits of exercise, the pulse rate's response to exercise practically parallels the total oxygen cost of the work and the minute volume of the work. The time necessary for the pulse to return to normal approximately parallels the circulatory-respiratory system's ability to buffer the fatigue products in the blood after exercise and to restore normality.

Cotton, Rapport, and Lewis[11] state that the rate of the pulse immediately after exercise is a gage of the degree of distress produced

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[10] Thomas K. Cureton, Physical Fitness Appraisal and Guidance, (St. Louis: C. V. Mosby Company, 1947), pp. 162-192.

[11] T. F. Cotton, D. I. Rapport, and Thomas Lewis, "After Effects of Exercise on Pulse Rate and Systolic Blood Pressure in Cases of Irritable Heart", Heart, VI, 1917, p. 269.

in the cardiovascular system. Therefore, the effect of exercise may be known by a systematic study showing the effect of the pulse rate. Bowen[12] appears to be the first physical educator to study the pulse rate systematically as related to exercise and physical fitness. He concluded that the pulse rate is due to (1) the speed of the exercise, (2) the effort in the exercise, (3) the physiological condition of the subject, and (4) to the age, posture, and mental state of the subject.

The normal pulse varies in different individuals. Schneider and Truesdell[13] found that young men in the recumbent position, the pulse rate varied from 42 to 117 beats per minute, the mean rate being 74. In 72 percent of the men, the reclining pulse was under 80. In 36 percent it was 70 or less, and in only 11 percent is was 60 or less, while 9 percent had 90 or more. Karpovich[14] found the average pulse rate in healthy Army Air Force flying students in a sitting position to be 75, the range being 50 to 106. The American Heart Association accepts as normal a range of 50 to 100. It is obvious, then, that in dealing with an individual it is important to determine his normal rate.

The difference between the standing and reclining pulse rate as

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[12]W. Y. Bowen, "Changes in Heart Rate, Blood Pressure, and Duration of Systole Resulting from Bicycling", American Physical Education Review, VIII, 1903, p. 8.

[13]Edward C. Schneider and Peter V. Karpovich, Physiology of Muscular Activity, (Philadelphia: W. B. Saunders Company, 1948), pp. 137-197.

[14]Edward C. Schneider and Peter V. Karpovich, Physiology of Muscular Activity, (Philadelphia: W. B. Saunders Company, 1948), pp. 137-197.

related to physical fitness has been very extensively studied. Morehouse and Miller[15] point out that, on the whole, men who are physically fit show a smaller difference between standing and reclining rates than do men who are less fit. A slow rate in the standing and reclining position with a small difference between the two is regarded as a sign of excellent physical condition. Crampton[16] found that the pulse rate did not rise as much in vigorous subjects as in "wearied" subjects, increasing as much as 44 beats per minute in the latter. Meylan[17] listed as normal an increase lower than 6 beats per minute. Giegal[18] concluded that an increase of more than 30 to 50 beats indicated weakened heart function. In their study of 2000 young men, who were judged by clinicians to be well, Schneider and Truesdell[19] found that the difference between the pulse frequency for the horizontal and erect postures ranged from 15 to 57.

In general the resting pulse rate of a man in training is from 6 to 8 beats slower than when he is out of condition. In strong athletes the pulse rates may be 10 or 20 or even 30 beats slower than in men of

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[15]Laurence E. Morehouse and Augustus T. Miller, Physiology of Exercise, (St. Louis: C. V. Mosby Company, 1953), pp. 72-123.

[16]C. W. Crampton, "The Blood Ptos's Test and Its Use in Experimental Work in Hygiene", Proceedings of the Society of Experimental Biology and Medicine, XII, 1915, p. 119.

[17]G. I. Meylan, "Twenty Hears Progress in Test Efficiency", American Physical Education Review, XVIII, 1913, p. 441.

[18]Thomas K. Cureton, Physical Fitness Appraisal and Guidance, (St. Louis: C. V. Mosby Company, 1947), p. 166.

[19]Edward C. Schneider and Peter V. Karpovich, Physiology of Muscular Activity, (Philadelphia: W. B. Saunders Company, 1948), pp. 137-197.

sedentary habits.

A quick recovery of the pulse rate to standing normal after exercise is one characteristic of fitness. Cureton[20] feels that it is one of the most valid tests if the exercise is hard enough. Cook and Pembrey[21] compared trained and untrained subjects and found that the rate of pulse rate recovery in trained subjects is much faster.

Meakins and Gunson[22] concluded that healthy subjects should return to standing normal pulse rate in 60 seconds after climbing 27 steps at a brisk walk. Bowdler and Flack[23] felt that the pulse should return to standing normal 30 seconds after 18 inch step-up on a chair 5 times in 15 seconds and that an increase in pulse rate over 25 is considered in the unfit class.

Blood Pressure

The circulation of the blood is made possible by the presence of pressures in the circulatory system which are highest in the ventricles of the heart at the instant of their contraction, which diminish progressively through the arteries and the capillaries, and which become lowest in the veins.

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[20] Thomas K. Cureton, Physical Fitness Appraisal and Guidance, (St. Louis: C. V. Mosby Company, 1947), p. 166.

[21] F. Cook and M. S. Pembrey, "Observation on the Effect of Muscular Exercise on Man", American Journal of Physiology, XLV, 1913, p. 441.

[22] J. C. Meakins and E. B. Gunson, "Special Report of the Medical Research Committee", (London: 1918), p. 27.

[23] Thomas K. Cureton, Physical Fitness Appraisal and Guidance, (St. Louis: C. V. Mosby Company, 1947), pp. 174-177.

The expression "blood pressure" means the lateral pressure exerted on the walls of the vessels by the contained blood. The factors upon which blood pressure depends are (1) the pumping action of the heart, (2) the peripheral resistance offered to the outflow of the blood from the arteries which varies with elasticity and vasoconstriction, and (3) the volume of the circulating blood. Arterial blood pressure of man is usually determined in the brachial artery of the arm. It is considered indicative of the pressure of the arteries generally, although the pressure varies from artery to artery.

Arterial pressure, which is the pressure we are most interested in, is divided into systolic and diastolic pressure. The maximum pressure caused by the systole, or contraction of the heart, is spoken of as the systolic pressure; the minimum pressure in the artery between heart beats, that is, the pressure at the end of the diastole of the heart, is known as the diastolic pressure.

The difference between systolic and diastolic pressure is designated as the pulse pressure. The systolic pressure is considered an index of the heart energy expended and indicates the strain to which the arteries are subjected. The diastolic pressure is generally considered a measure of the peripheral resistance to the circulation of the blood and therefore, an index of vasomotor tone. It indicates the work the heart must perform in that no blood is expelled from the ventricles in systole until the ventricular pressure just exceeds the diastolic pressure.[24]

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[24]Edward C. Schneider and Peter V. Karpovich, Physiology of Muscular Activity, (Philadelphia: W. B. Saunders Company, 1948), pp. 137-197.

The quantity of blood passing through different organs is not constant from time to time and may be altered by variations in activity. The blood pressure is changed during physical activity in order to provide adequate blood supply at all times to the active muscular, cardiac, and nervous tissue. This variation is brought about by the regulatory activity of the vasomotor and cardiac centers in the brain.

Sarah R. Reidman[25] makes the following description of blood pressure:

> The measuring of blood pressure in man is one of the techniques used by the physical education student in performing most of the circulatory test of physical fitness. The effectiveness of an athlete or the fitness of any other person for a task depends in part upon his ability to return to physiological equilibrium. The ability to maintain a blood pressure not much higher than that at rest and the ability to achieve a resting pressure directly after exercise are among the indexes of fitness for a task. Excessive fluctuations in blood pressure and delayed return to the resting level are signs of poor physical condition. Very moderate exercise, such as slow walking, affects systolic pressure little and diastolic pressure hardly at all. In more vigorous exercise, the systolic pressure rises within the first 5 to 8 minutes and remains at that level throughout the activity. Immediately after exercise the systolic pressure begins to drop and returns to the basal or resting level within about the same time that it took for it to rise. In a subject in good condition the curve of diastolic pressure follows about the same pattern. In an individual who is not up to the task, the picture is quite different. There is about the same rise in systolic blood pressure, but this rise is not sustained. The systolic blood pressure begins to fall during the exercise and may fall even below the basal level, thus often terminating the act. It usually remains low for some time after exercise has ended. In such subjects, too, the diastolic pressure is inadequate. It rises only slightly, but the rise is not sustained and the diastolic pressure falls below the resting rate.

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[25]Sarah R. Reidman, Physiology of Work and Play, (New York: The Dryden Press, 1950), pp. 225-241.

It has been found that the systolic pressure increases with the severity of work, whereas the diastolic pressure increases only slightly. In normal adults the systolic pressure varies between 110 and 140 mm, the diastolic pressure between 65 and 90 mm. The type of exercise determines the extent and rate of increase. In exercises of endurance, such as long distance walking or swimming, the blood pressure rises slowly and to a lower height than in exercise of speed and strength. In lifting exercises, the blood pressure rises quickly and to a great height. In exercises of speed, the adjustment is slower.

Cureton[26] cites that in all forms of exercise there is usually some rise in systolic pressure in proportion to the work done. Under considerable exertion the systolic blood pressure rises steadily and the diastolic pressure falls. After rest both return to normal or very close to normal. Lowsley[27] has shown that systolic blood pressure temporarily increases considerably due to exercise and returns to normal more or less slowly, usually becoming subnormal. The time to return to normal is proportional to the severity of the exercise. Cureton[28] points out that after the exercise there is in trained subjects a very rapid return to normal, but in poorly-conditioned subjects the systolic blood pressure

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[26]Thomas K. Cureton, Physical Fitness Appraisal and Guidance, (St. Louis: C. V. Mosby Company, 1947), p. 208.

[27]O. S. Lowsley, "The Effects of Various Forms of Exercise on Systolic, Diastolic, and Pulse Pressures and Pulse Rate", American Journal of Physiology, XXVII, 1911, pp. 446-466.

[28]Thomas K. Cureton, Physical Fitness Appraisal and Guidance, (St. Louis: C. V. Mosby Company, 1947), p. 208.

may fall after the exercise to below the normal and then gradually return to normal as fatigue is eliminated. Cureton further states that severe training in endurance activities seems to raise the lying systolic and diastolic blood pressure. There is some evidence to show that unusually high systolic blood pressure will reduce somewhat under a gradual program of regular exercise and hygienic living. During exercise, diastolic blood pressure may fall and such lowering is interpreted as an indication of fatigue because during recuperation the diastolic pressure gradually rises again. The diastolic pressure does not fall much in well-trained men but only in men considerably out of condition. Furthermore the failure of diastolic pressure to return to the normal level after exercise indicated residual fatigue in the cardiovascular system.

Crampton[29] assumes that in strong, healthy people the systolic blood pressure should rise in changing from lying to standing position and that the ideal condition would show a maximum rise, also that the poorer the condition the greater would be the fall in systolic blood pressure and the greater would be the corresponding rise in pulse rate. Cureton[30] cites that evidence has been accumulated to show that in the normal rested state there are practically no postural changes in systolic blood pressure with well-conditioned athletes, but the changes in systolic blood pressure is either plus or minus with poorly-conditioned subjects

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[29]C. W. Crampton, "Blood Pressure I, II, III, IV, V", Physical Education Review, X, December, 1905, pp. 275-283.

[30]Thomas K. Cureton, Physical Fitness Appraisal and Guidance, (St. Louis: C. V. Mosby Company, 1947), pp. 197-199.

becoming more unstable in proportion to the unfitness of the subject, indicating poor stability and control of the splanchinic. He further points out that in a study of 1024 men it was shown that the untrained men had the greatest increase and the best-trained men had practically no increase in systolic pressure. According to Bainbridge[31] low systolic pressure is common in weak subjects. Tyndale[32] has emphasized that systolic blood pressure above 160 and below 90 should be considered seriously as a warning of poor health. Variations in between mean very little.

Cureton[33] feels that relatively high diastolic pressure in lying, sitting, and standing position in normal healthy men is a fairly good indication of condition. Several studies have given evidence that relatively high diastolic blood pressure in the quiet state goes with good condition. Savage[34] found relatively high diastolic pressure and low pulse pressure among 55 marathon runners measured just before their Pittsburgh Marathon race of 1909. The fact that these men were trained to compete in a run of 26 miles 385 yards, is in itself evidence that they were functionally fit for running. Cureton[35] points out, that an

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[31]Thomas K. Cureton, Physical Fitness Appraisal and Guidance, (St. Louis: C. V. Mosby Company, 1947), pp. 197-199.

[32]W. R. Tyndale, "Blood Pressure as an Indication of Condition", Proceedings and Addresses of National Education Association, (Salt Lake City), 1913.

[33]Thomas K. Cureton, Physical Fitness Appraisal and Guidance, (St. Louis: C. V. Mosby Company, 1947), p. 201.

[34]W. L. Savage, "Physiological and Pathological Effects of Severe Exertion", American Physical Education Review, December, 1910.

[35]Thomas K. Cureton, Physical Fitness Appraisal and Guidance, (St. Louis: C. V. Mosby Company, 1947), p. 201.

acceptable logic for diastolic blood pressure in the quiet state seems to be centered around the concept that a strong heart with good supporting aortic elasticity and tone seems to maintain a somewhat higher diastolic blood pressure.

The Heartometer

Cureton[36] feels that there is an increasing need in the field of health and physical education for a device to encourage people to acquire and maintain cardiovascular fitness. He states, "The Cameron Heartometer, within certain limits, fulfills this need besides providing a systematic and objective record of systolic and diastolic blood pressure, pulse pressure, heart rate, and an objective recording of heart valve action".

The main use of the machine is to show the difference between normal individuals in present cardiovascular condition and the same individuals in a state of various amounts of cardiovascular fatigue. There is no intention that this machine be used in health and physical education to diagnose heart disease.[37]

The heartometer visually and graphically portrays the force of the heart, the pressure and velocity of the blood in the arteries, and the phenomenon of the pulse wave, on a circular type graph known as the heartograph (Figure 1). From this graph we are able to get diastolic

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[36]Thomas K. Cureton, Physical Fitness Appraisal and Guidance, (St. Louis: C. V. Mosby Company, 1947), p. 232.

[37]Anonymous, The Heartometer in the Field of Physical Education, (Chicago: Cameron Heartometer Company, 1954).

TYPICAL HEARTOGRAPH

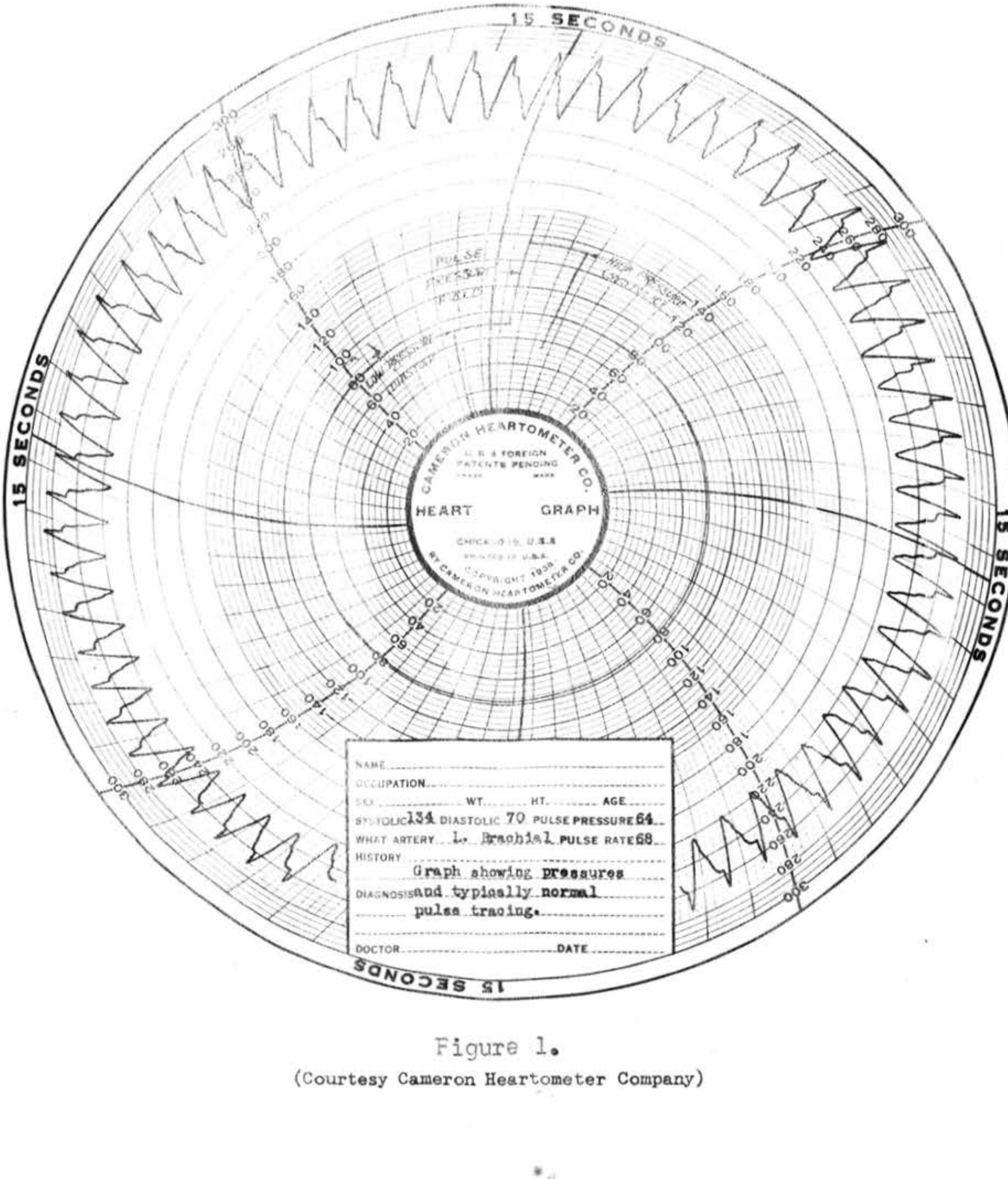

Figure 1.
(Courtesy Cameron Heartometer Company)

and systolic blood pressure, pulse rate, pulse pressure, and different interpretations from the pulse wave tracing about the valves of the heart and arteries. The interpretation which this study deals with is known as the fatigue ratio.

Fatigue Ratio

In the use of the heartometer, this measurement is the ratio of the amplitude of the dicrotic notch to the amplitude of systole as measured by the vernier calipers, or DE/AB (Figure 2). Normally the dicrotic notch, which corresponds to the closing of the aortic semilunar valves, appears one-third but not below one-half down the systolic amplitude. The low dicrotic notch is quite likely due to apprehension and vasodilation, or to fatigue of the cardiovascular mechanism which leaves the subject with some vasodilation and lowered arterial tone. The more slowly the valves close, the lower is the diastolic blood pressure acting to snap the valves shut and consequently the height of the dicrotic notch is lower than normal. Good cardiovascular condition is normally associated with a relatively high dicrotic notch compared to the systolic amplitude when the subjects are mentally and physically at rest.[38]

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[38] Anonymous, The Heartometer in the Field of Physical Education, (Chicago: Cameron Heartometer Company, 1954).

CARDIAC CYCLE WITH VARIOUS FACTORS

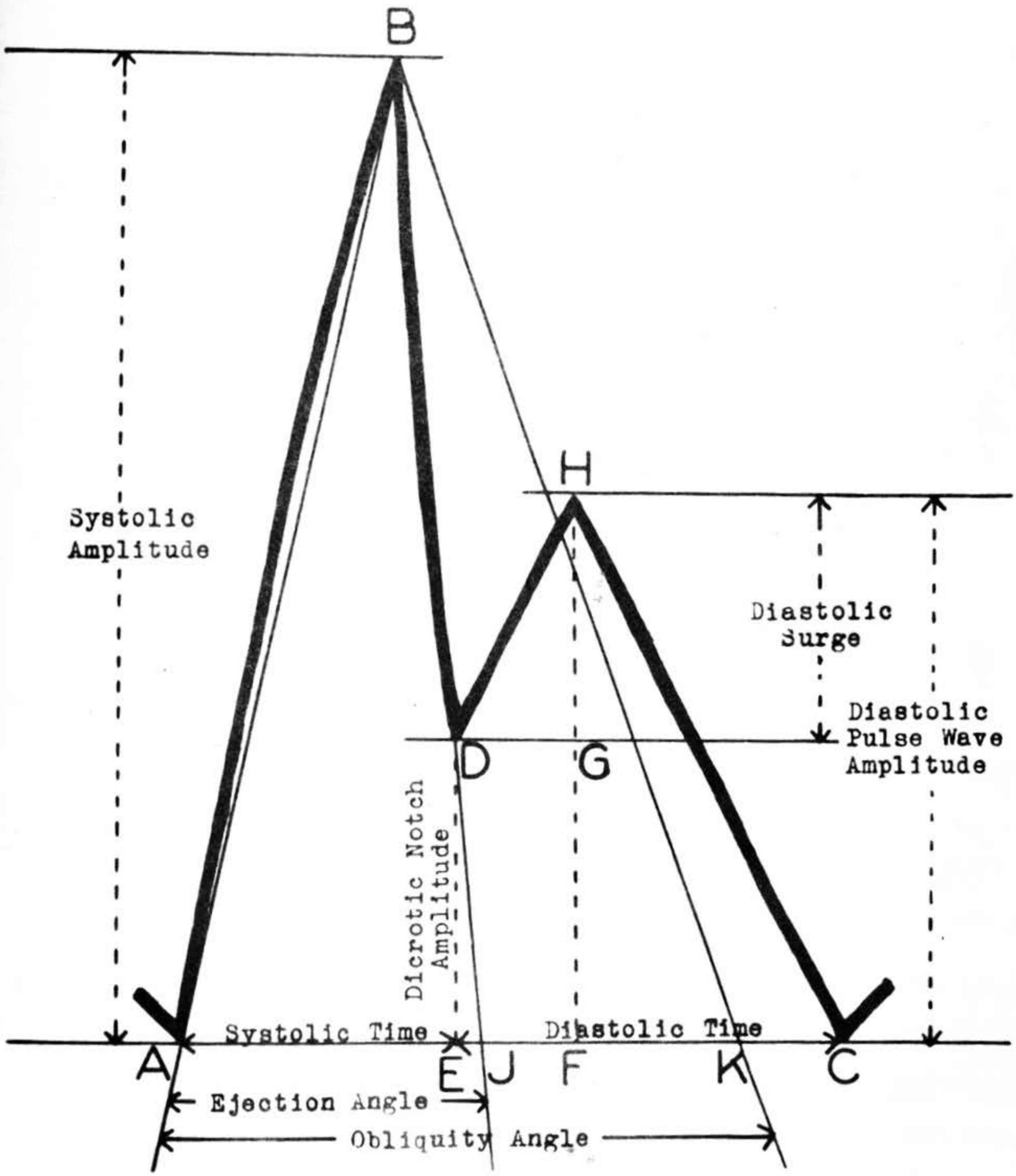

Figure 2.

(Courtesy Cameron Heartometer Company)

CHAPTER III

COLLECTION OF DATA

The sample was made up of forty male students who were enrolled in the freshman general physical education course at South Dakota State College. When the class met for the first time in the winter quarter, there were forty-five students in the class. During the first class period the students were given the Roger's Physical Fitness Test. The physical fitness indices from this test were used to equate the two groups. Group I consisted of those individuals that had a physical fitness index of eighty-six and above. Group II consisted of individuals that had a physical fitness index of eighty-five and below. Five of the students dropped from the class for various reasons, leaving a total of forty subjects.

During the first week of the winter quarter, each individual was given two tests to determine his cardiovascular condition. The first test was to determine the subject's pulse rates at different postural positions and was given in the following manner. The entire class of forty individuals was asked to go into a room and stand quietly for a period of ten minutes. After the subjects were in the room for the prescribed period of time, the standing pulse rate was taken. As soon as the standing pulse rate was taken, the subject lay on a mat and the tester proceeded to the next subject. This sequence continued until each subject's standing pulse rate had been taken and everyone was in a reclining position. The tester then returned to the first man and took his lying pulse rate. The subject was then asked to stand and his standing pulse rate was immediately taken. The pulse rate was taken again after the subject had been standing for two minutes. The tester would then move to the next subject and go through the same process with him. Each individual spent approximately the same amount of time in each position. The entire class was tested during a one hour period with two individuals, Dr. Snowberger and the author, administering the test.

Test II was given to the two groups using the Cameron Heartometer as the measuring instrument. Factors measured were pulse rate, systolic and diastolic blood pressure, and fatigue ratio. These factors were measured before the subjects participated in activity, immediately after activity, and ten minutes after completion of activity. The activity consisted of a three and one tenth mile hike with the individual carrying a twenty-five pound army pack. The army pack was carried at the "high pack" position. The hike course was set up in the following manner. The three and one tenth miles were broken down into time intervals. The subjects would walk a certain time interval and then jog a specific time interval. To insure reliability of time, the subjects carried a stop watch. The places where the subjects were to change from a walk to a jog were clearly marked by landmarks and they also had a map with the places clearly indicated. The time for the completion of the entire hike was thirty-two minutes. Each individual left on the hike at fifteen minute intervals so as to facilitate in testing when they returned.

The Roger's Physical Fitness Test and the above two cardiovascular tests were given to the two groups the first week of the winter quarter. After these tests were given, the students began an eight week conditioning program. This program was carried out during the regular physical education classes, which met for forty minutes per day, two days per week. The activities were conditioning exercises, weight lifting, rope climbing, gymnastics, apparatus work, combatives, relays, and team games. Each individual was required to perform the same activities for the same length of time, regardless of which group he belonged to if his endurance and strength permitted.

After the completion of the eight-week conditioning program, the subjects were given the Roger's Physical Fitness Test and the two cardiovascular tests for the second time.

CHAPTER IV

TREATMENT OF DATA

Statistical Treatment

To determine the effects which the developmental physical education program had on the physical fitness indices and the various cardiovascular factors, a statistical analysis was made of the data obtained from the two groups.

Comparisons of the mean scores of each test following the developmental program were made with the pre-developmental program mean scores. The significance of the difference between means was tested by the t-ratio. The t-ratio formula used was for correlated groups.[39]

To determine if the physical fitness index was any indication of cardiovascular condition, coefficient of correlations were computed by means of the Pearson Product Moment method. These correlations were computed both prior to and after the developmental program between physical fitness index and (1) standing pulse rate, (2) standing to lying pulse rate difference, (3) lying to standing pulse rate difference, (4) pre-exercise pulse rate, (5) pre-exercise systolic blood pressure, (6) pre-exercise diastolic blood pressure, and (7) pre-exercise fatigue ratio. The significance of the correlations was computed by the formula

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[39] E. F. Lindquist, A First Course in Statistics, (Cambridge: Houghton Mifflin Company, 1942), pp. 135-136.

$$t = r\sqrt{\frac{N-2}{1-r^2}}\ .$$[40]

To test the significance of mean difference, nineteen degrees of freedom were used making t values of 2.095 and 2.86 significant at the .05 and .01 level of confidence respectively. For the significance of the coefficient of correlation, eighteen degrees of freedom were used with t values of 2.10 and 2.88 denoting significance at the .05 and .01 level of confidence respectively.

Interpretations of Results

The results of this study appear in Tables I and II. Appropriate interpretations of these results are as follows:

1. The physical fitness indices of both groups improved after participating in the eight week developmental program. Group II, the students with low physical fitness indices, showed the greatest improvement, an improvement of 7.75, which is highly significant beyond the .01 level of confidence. The mean scores of Group I, the students with high physical fitness indices, improved, but the mean difference approaches but did not reach the .05 level of confidence.

2. The pulse rate of Group I, both before and after the developmental program, was lower at all postural positions than the pulse rates of Group II. Both groups showed a decrease of pulse rates after the developmental program. The mean decreases of Group II were more sig-

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[40] J. P. Guilford, Fundamental Statistics in Psychology and Education, (3rd Edition; New York: McGraw Hill Book Company Inc., 1956), p. 219.

Table I

Pre- and Post- Developmental Program Statistics of Group with Physical Fitness Indices of Eighty-Six and Above (Group I)

Test	Pre-Program Mean	Post-Program Mean	M_d	M_d t-ratio	Pre-Program r	Post-Program r	Pre-Program r t-ratio	Post-Program r t-ratio
1. Physical Fitness Index-----	99.65	104.25	4.6	1.95				
2. Standing Pulse Rate--------	77.75	76.5	-1.25	2.06	.03	-.56	.04	2.8
3. Difference of Standing to Lying Pulse Rate----------	15.25	12.75	-2.5	3.3	-.28	-.32	1.28	1.43
4. Difference of Lying to Standing Pulse Rate--------	17.75	11.35	-6.4	1.8	.17	-.44	.22	2.4
5. Pulse Rate After Two Minutes Standing----------	77.5	74.75	-2.75	2.6				
6. Pre-Exercise Pulse Rate----	76.7	75.25	-1.45	1.3	.06	-.41	.08	1.9
7. Post-Exercise Pulse Rate---	102.3	99.	-3.3	.7				
8. Pulse Rate Ten Minutes After Exercise------------	93.5	91.85	-1.65	.5				
9. Pre-Exercise Systolic Blood Pressure------------	124.5	130.1	5.6	1.2	.02	.16	.008	.05
10. Post-Exercise Systolic Blood Pressure------------	121.3	143.	21.7	2.02				
11. Systolic Blood Pressure Ten Minutes After Exercise-	121.3	120.	-1.3	.4				
12. Pre-Exercise Diastolic Blood Pressure------------	62.55	64.25	1.7	.9	.009	.06	.001	.09
13. Post-Exercise Diastolic Blood Pressure------------	65.25	61.7	-3.55	.5				
14. Diastolic Blood Pressure Ten Minutes After Exercise-	64.25	62.5	-1.75	.9				
15. Pre-Exercise Fatigue Ratio-	.451	.509	.058	.4	.09	.47	.1	2.2
16. Post-Exercise Fatigue Ratio-	.377	.389	.012	.9				
17. Fatigue Ratio Ten Minutes After Exercise------------	.478	.463	- .015	.5				

Table II

Pre- and Post- Developmental Program Statistics of Group with Physical Fitness Indices of Eighty-Five and Below (Group II)

Test	Pre-Program Mean	Post-Program Mean	M_d	M_d t-ratio	Pre-Program r	Post-Program r	Pre-Program r t-ratio	Post-Program r t-ratio
1. Physical Fitness Index-----	75.	82.75	7.75	4.4				
2. Standing Pulse Rate--------	87.17	80.75	-6.42	3.33	-.43	-.37	2.01	1.6
3. Difference of Standing to Lying Pulse Rate-----------	17.25	12.	-5.25	2.48	-.07	.23	.03	1.
4. Difference of Lying to Standing Pulse Rate--------	21.85	19.1	-2.75	2.6	-.12	-.37	.6	1.7
5. Pulse Rate After Two Minutes Standing-----------	90.9	82.3	-8.6	3.1				
6. Pre-Exercise Pulse Rate----	78.25	76.5	-1.75	.3	-.14	-.27	.6	1.4
7. Post-Exercise Pulse Rate---	110.7	106.	-4.7	.9				
8. Pulse Rate Ten Minutes After Exercise-------------	102.5	97.75	-4.75	.4				
9. Pre-Exercise Systolic Blood Pressure------------	124.7	133.	8.3	2.7	.31	.31	1.3	1.3
10. Post-Exercise Systolic Blood Pressure------------	139.9	142.5	2.6	1.06				
11. Systolic Blood Pressure Ten Minutes After Exercise-----	116.1	127.75	11.65	2.6				
12. Pre-Exercise Diastolic Blood Pressure------------	65.5	67.1	1.6	2.27	-.26	-.21	1.1	.9
13. Post-Exercise Diastolic Blood Pressure------------	69.1	64.5	-4.6	1.14				
14. Diastolic Blood Pressure Ten Minutes After Exercise-	64.5	71.55	7.05	.6				
15. Pre-Exercise Fatigue Ratio-	.435	.444	.009	.6	-.72	-.34	4.3	1.5
16. Post-Exercise Fatigue Ratio-	.229	.273	.044	4.4				
17. Fatigue Ratio Ten Minutes After Exercise------------	.409	.441	.032	1.16				

nificant, with standing pulse rate having a t-ratio of 3.33, which is highly significant at the .01 level of confidence. The difference between standing to lying pulse rate has a t-ratio of 2.48, which is significant beyond the .05 level of confidence. The difference between lying to standing pulse rate had a t-ratio of 2.6, which is significant beyond the .05 level of confidence. The two-minute standing pulse rate had a t-ratio of 3.1, which is significant beyond the .01 level of confidence.

The coefficient of correlation between physical fitness index and the various pulse rates was not high for either group, but there was a tendency for a better correlation to be present after the developmental program. None of the correlations for Group I were significant at the .05 or .01 level of confidence. Two of the correlations computed for Group II were significant at the .05 level of confidence, both being after the developmental program. These two were standing pulse rate, which had a t-ratio of 2.8, and pulse rate two minutes after standing, which had a t-ratio of 2.4.

3. The pulse rate as measured by the heartometer prior to, immediately after, and ten minutes after exercise was slightly lower in Group I than in Group II. Both groups showed somewhat lower pulse rates after the developmental program, but none of the mean decreases were significant.

The systolic blood pressure as measured by the heartometer prior to, immediately after, and ten minutes after exercise was slightly higher in Group I than in Group II. The mean scores of pre- and post- exercise systolic blood pressure increased in Group I after the developmental program, but the increases were not significant. Only the mean increase of pre-exercise systolic blood pressure was significant in Group II, being significant beyond the .05 level of confidence. The systolic blood pressure measured ten minutes after the completion of exercise dropped below the pre-exercise level in both groups both before and after the developmental program. The diastolic blood pressure was so inconsistent and variable that an adequate interpretation could not be made.

4. Group I had a higher fatigue ratio prior to and after the developmental program than did Group II. Both groups increased their pre-exercise fatigue ratio after the developmental program, but neither increase was significant. Group I did not show a significant increase of post-exercise fatigue ratio, but Group II showed an increase of .044, which was significant beyond the .01 level of confidence. The fatigue ratio taken ten minutes after the completion of exercise for Group II dropped below its pre-exercise level prior to the developmental program and was only three points above the resting level after the conditioning program. Group I was twenty-seven points above the pre-exercise level ten minutes after completion of the exercise prior to the developmental program and dropped below the pre-exercise level after the program. The reason for this variability was not determined.

CHAPTER V

SUMMARY AND CONCLUSIONS

The purpose of this study was to determine the effects of an eight-week developmental physical education program on physical fitness index and cardiovascular condition of twenty male students with a physical fitness index of eighty-six and above and of twenty male students with physical fitness indices of eighty-five and below.

Prior to the developmental program, each subject was given the following tests: (1) Roger's Physical Fitness Test; (2) a group of pulse rate tests composed of standing pulse rate, difference between standing to lying pulse rate, difference between lying to standing pulse rate, and pulse rate after two minutes standing; and (3) a third test consisting of pulse rate, systolic blood pressure, diastolic blood pressure, and fatigue ratio as measured by the Cameron Heartometer prior to, immediately after, and ten minutes after participation in a three and one-tenth mile hike, carrying a twenty-five pound army pack. These same tests were given to the forty subjects after the completion of the eight-week developmental program.

A statistical analysis, using pre- and post- program mean scores, mean differences, t-ratios, and coefficient of correlation, was made of the data in order to interpret the results.

From the results the following conclusions seemed to be justified:

1. The developmental physical education program given the subjects of this study appeared to have increased the physical fitness index and

decreased the pulse rates of both groups, but the effect on systolic and diastolic blood pressure, and fatigue ratio was somewhat questionable. Generally one would think that the program would need to be of longer duration to show great cardiovascular changes.

2. The individuals with the lower physical fitness indices generally showed more significant improvement of physical fitness index and more significant decreases of pulse rate than did the individuals with the higher physical fitness indices.

3. The increases of systolic and diastolic blood pressure and fatigue ratio, although questionable and inconsistent, were in the direction commonly associated with good cardiovascular condition.

4. Generally, individuals with the higher physical fitness index tended to have lower pulse rates, slightly higher systolic blood pressure, and higher fatigue ratios than those individuals with the lower physical fitness indices. The data plotted on a scattergram and the correlations serve to substantiate this conclusion.

There are certain limitations on a study such as this which aid in pointing out possible further research in this area of knowledge. Following are some general suggestions:

1. The length of the developmental program should be increased, both the number of meetings per week and the length of each meeting.

2. The sample should be larger; and if the sample is equated, there should be a larger interval between the "cut-off" scores.

3. The statistical analysis of the material should be more extensive. It is recommended that the data be treated with an analysis of variance.

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